ARCH 631. Topic 21 Reading Notes

- Most heavy steel systems are comprised of one way elements from a variety of structural (cross section) shapes; pin connections are preferred; rigid connections aren't too difficult to construct
- Beams are usually wide flange shapes; channels are sometimes used (tend to twist – so they are good anchored to masonry walls, as are angles, to support joists)
- Trusses have a variety of shapes and lengths and span ranges; open-web joists are an economical solution for light, uniformly distributed loads (like roofs) and for long spans; because open-web (or bar joists) are simply supported, they don't contribute any lateral resistance; joist girders exist
- Composite construction refers to two structural materials that act *together*; composite systems with steel are typically concrete (and not described as reinforced concrete or reinforced masonry); to act together in bending there are shear studs in a steel beam or deck to tie the concrete to the steel; "concrete-wearing" refers to having concrete on the steel deck to make a flat floor and it might as well be used structurally instead of as dead load
- Plate girders are wide flange sections built of plates and are usually used for long spans like in bridges or as transfer girders
- Rigid arches can be made into any shape and of solid sections or open web sections; pre-manufactured ones are common for short to moderate spans
- Space frame structures are typically steel for long spans
- Shells are possible with steel; it is tricky using straight line elements to establish double curvature; curved segments are possible by pressing (cold forming) steel sheets; domes can be ribbed or geodesic
- Cables are extensively made of steel
- Steel columns typically have t/h or (t/d) ratios from 1:24-1:9
- Beams can be designed based on serviced loads and allowable stresses (though not as common any more); rolled sections are standard shapes; built-up section are custom shapes; because there are standard shapes, the section modulus can be put in tables for design aids; select a section, then evaluate for shear, deflection and other design issues
- In wide flanges the number after the W is the nominal depth with the second number (after the x) being the weight per linear foot; C's are channels; L's are angles; section modulus and moment of inertia are listed for x-x and y-y axes in shape tables along with other geometry; built up section must have the moment of inertia calculated with the parallel axis theorem
- Shear strength is a function of the area of the web (td)
- Compact section have the right proportion of geometry and do not have to be carefully examined for thin member (unbraced) behavior problems amongst others; flange buckling is possible under compression and must be designed for
- Steel has an linear elastic behavior under stress-strain loading and then plastic behavior (very little increase in stress with significant strain) after yield and eventually rupture; plastic hinge is the effect of all the fibers in the cross section yielding and having no more resistance to an increase in bending moment; the "section modulus" corresponding to the yield moment is called the *plastic section modulus* (Z)

- Plastic hinges in simply supported beams will cause an instability, but may not in an indeterminate structure where more hinges may be necessary for collapse;
- LRFD stands for Load and Resistance Factor Design and is a design method based on limit states and amplification of service loads (like 1.4D); R_n stands for nominal resistance, ϕ stands for resistance factor; R_u stands for the design quantity determined with the load factors; deflection are always determined from *unfactored* loads
- Allowable stress for high slenderness ratios (larger than C_c which is a function of E/F_y) has a similar form to the Euler equation: $12\pi^2E/23(kl/r)^2$; shorter columns buckle inelastically; kL/r is limited to 200